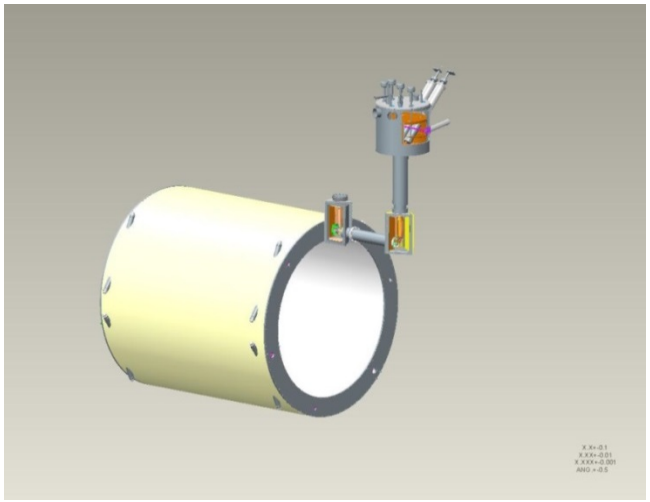
Magnet and Infrastructure

Existing PHENIX Cooling Water System

BaBar Coil Loaded and Ready for Transport to BNL

Existing PHENIX Experimental Facility



sPHENIX Superconducting Coil with Valve Box and Extension

Magnet and Infrastructure

- Subsystem Scope
  - 1.2 Magnet
    - Provide an Operating 1.5T Solenoid Magnet, associated Power Supply, Cryo System, Quench Detection, and Controls.
    - Install all Support Equipment, Hook Up, and R+T magnet.
    - Perform Magnet Field Map
  - 1.8 Infrastructure
    - Design and Fabricate Detector Main Support Cradle and Base along with Drive and Alignment System.
    - Design and Fabricate Magnet Pole Tips.
    - Design and Fabricate Support Bridge and Access System to Detector.
    - Modify as required and provide all ancillary support systems to detector such as A/C Power, Cooling Water, Cable ways, Building cooling and safety systems.

Magnet – Specification/Requirements*

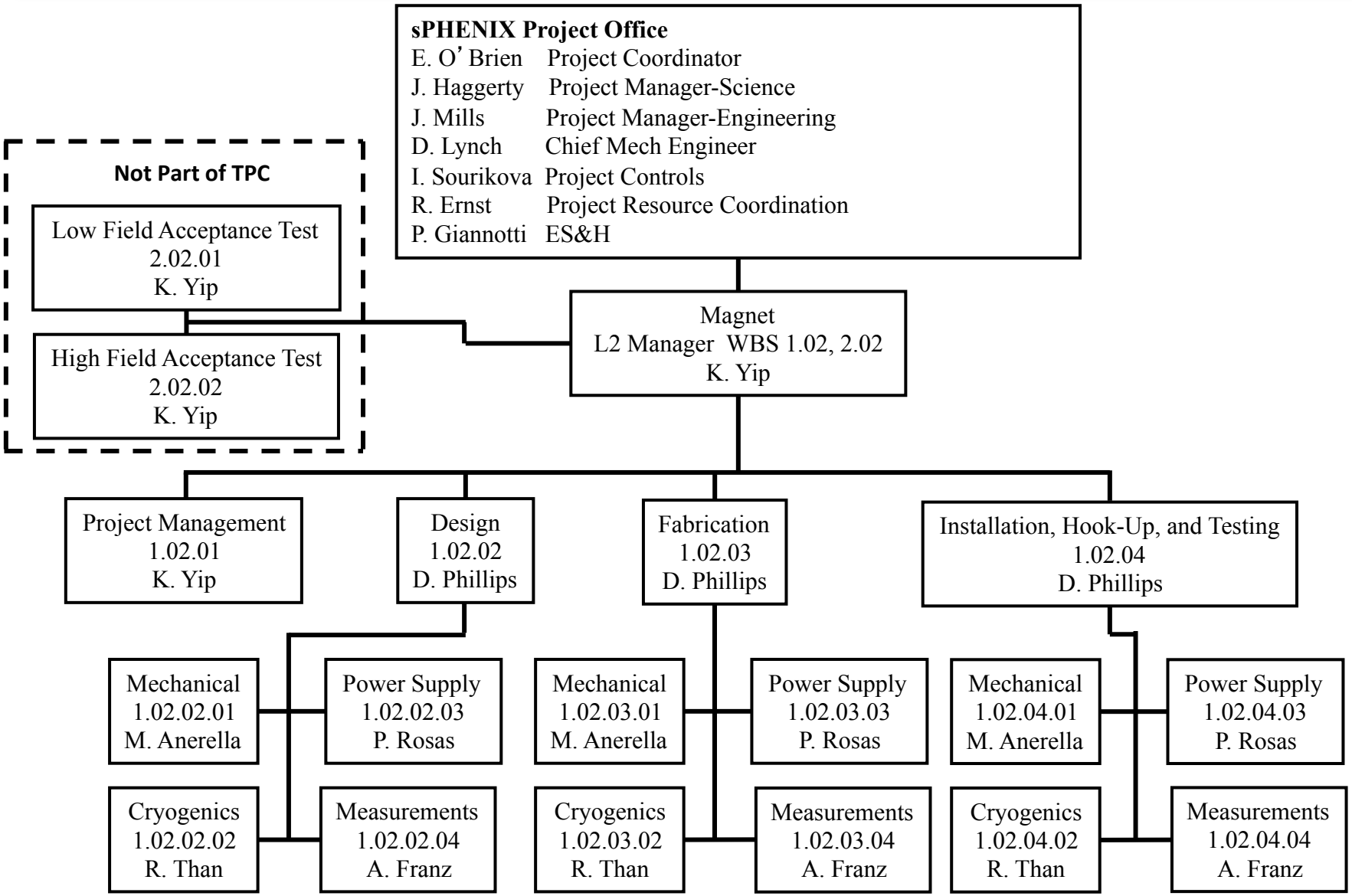
- Achieve 100 MeV Mass Resolution on Upsilons
- Coverage in full 2π (azimuth)
- Coverage in $|\eta| < 1.1$ (forward)
- 1.5 T Central Field
- Availability for Installation FY'20
- Field Measured to a few percent within Tracking Volume
- Communication/PLCs to be interfaced to the RHIC Cryogenic Systems DCS/ HMI control system via Ethernet
- Compatible with Potential Future EIC Detector
- Coil required to maintain robustness under potential quench.

*Requirements Established in sPHENIX PCDR

Magnet Subsystem Description

- Provide a superconducting solenoid that will meet the Performance Specification as outlined;
- Perform required Acceptance Tests of the BaBar Superconducting Solenoid and verify all support equipment works (not operated since 2008 and transported cross country);
- Provide DC Power Supply that is compatible with the requirements of the coil (4596A @ 20V -> 1.5 T Central Field);
- Provide a Magnet Quench Detection System, Dump Resistor, and Switch;
- Provide an operating Cryogenic System with associated support equipment (i.e. Turbo Vacuum Pump, Cryogenic Lines and Connectors, Controls and Communications, Pressure Relief Devices and Lines, Cryogenic Transfer Lines)
- Provide a Magnet Mapping Device and measure the magnetic field;

Magnet Organization Chart



Magnet Schedule and Resource Requirements

Key Dates

04/2015 Preliminary Acceptance Test (Completed)

01/2016 Low Field Test

12/2016 High Field Test

04/2016 Start Magnet Design

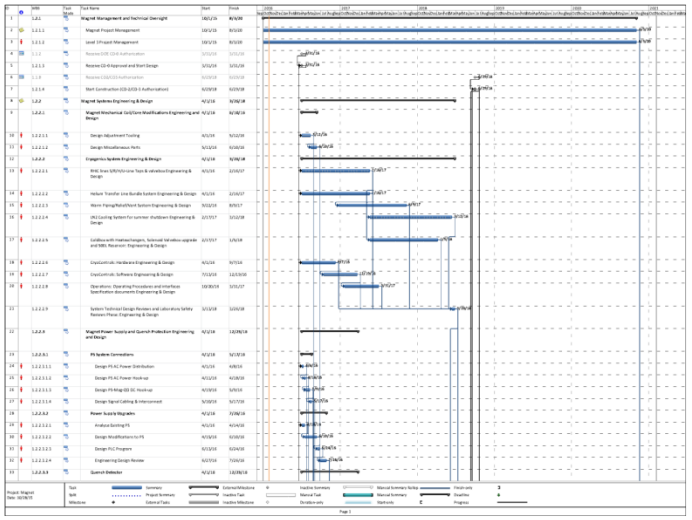
03/2018 Power Supply, Q/D, Cryo Design Complete

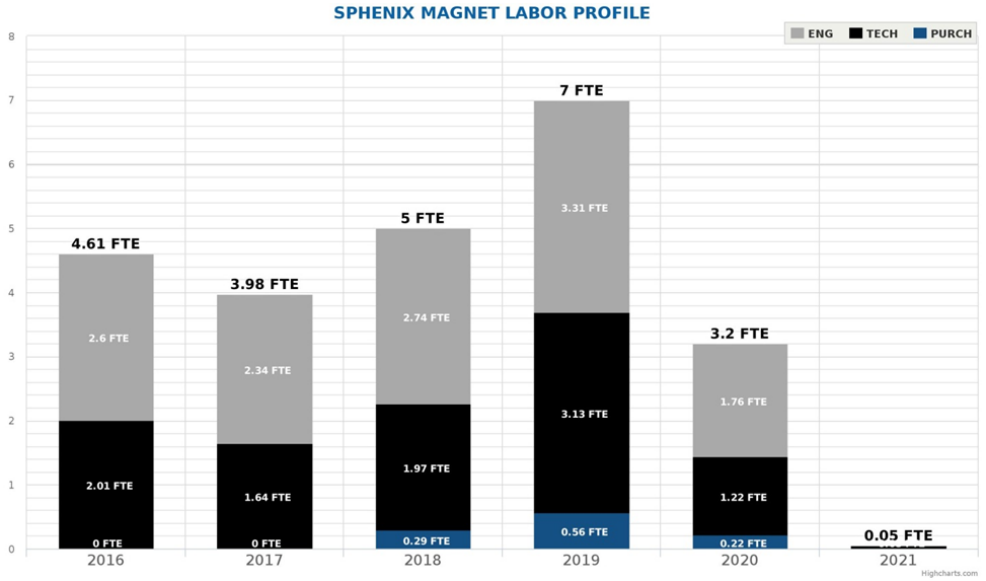
07/2018 Start Material Purchase and Fabrication

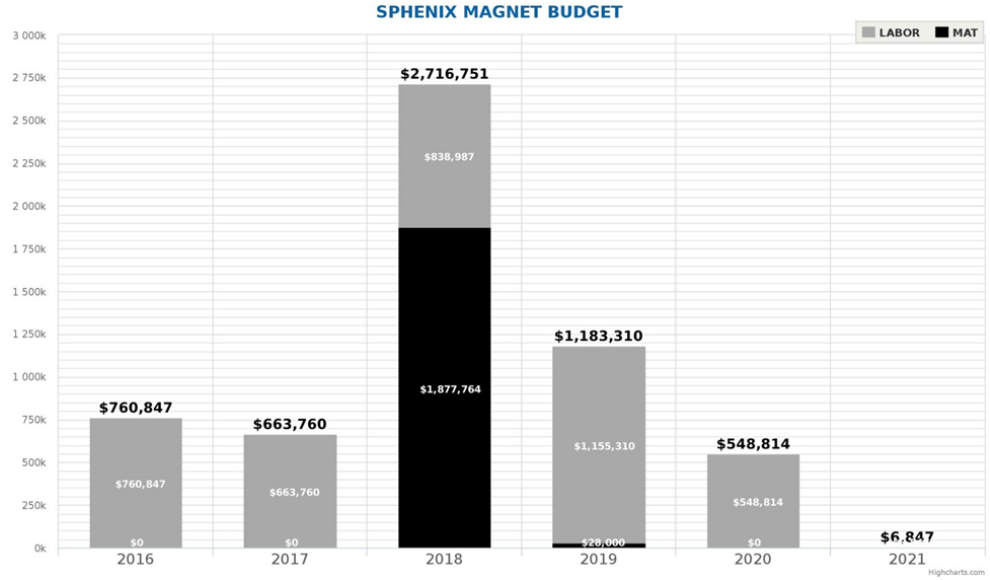
07/2019 Coil Ready to Install

03/2020 Pre-Op Lab Safety Review

Magnet Schedule







Magnet Cost and Schedule Drivers

- **Schedule Drivers**
  - Coil Tested Early/Valve Box Extension Modified Early (Positive Schedule Driver)
  - Installation of Cryo Piping/PS/QD (CAD Technicians)
  - Design of Cryo Distribution System
  - Run and Test, Mapping of the coil is on the Critical Path

- **Cost Drivers**
  - Cryo Piping Material Purchase ($1120.5K)
  - Cryo Installation and Pre-Op Testing ($938.3K).
  - Present plan to tap into RHIC Cryo has operational considerations. Dedicated Cryo Plant (not part of Ref. Design, Δ≈$1,000K)

Magnet Technical and Project Status

- **Technical**
  - Preparing for Low Current Cold Test
  - Designing Flux Return for High Field Test
  - Analysis of 2d/3d Magnetic Field and Generated Forces (internal coil forces and stresses, structural analysis of flux return steel, under both static and fault conditions).
  - Continued study of response of installed strain gages and linear displacement potentiometers.
  - Valve Box Extension to Shops for Fabrication (to be used in High Field Test)

- **Project**
  - Management structure in place for magnet subsystem.
  - Ongoing planning for Low Field/High Field Tests (bi-weekly meetings)
  - Preliminary magnet schedule completed
  - Basis of Estimate document started
  - Preliminary Bottom's-Up Estimate complete on magnet subsystem

Magnet Issues and Concerns

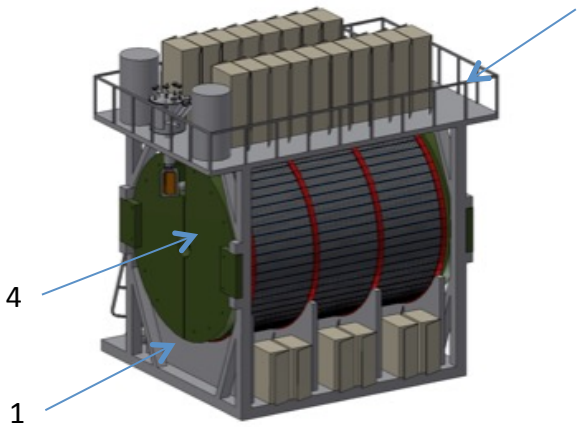
Issue	Mitigation
Verify we have a working magnet	Perform Low Field/High Field Test
Coordination of resources between Physics Department/Collider Accelerator Department/Magnet Division	Continue meeting with department/division management to develop long-term resource requirements for all NP programs.
Resolve Stand-Alone-Cryo Plant vs RHIC Cryo Tie-In	Perform in-depth study of operational issues and effects and cost estimate for out-year operations
Project time constraints do not allow for Magnet Mapping.	Investigate alternate in-situ field measurement approaches and the potential impact of field uncertainties on physics performance.

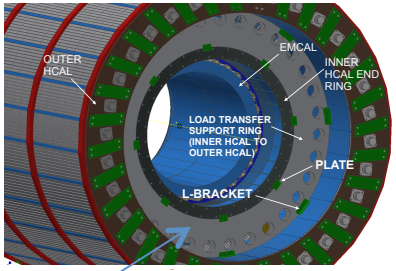
Specification/Requirements Infrastructure*

- Pole Tips
  - 204” OD x 24” ID x 12” Thick
  - Material – C1006 Magnet Steel
  - Detector Accessibility Requirements – Extended Maintenance (1week)
- Support Ring
  - Material – Stainless, 400 Series
  - Load Requirements – Transfer support loads from Inner HCal/EMCal to Outer Hcal
- Access Bridge
  - Accommodate Racks, Cryo Valve Box, Dewars (2), Controls
  - Design Floor Load Requirement – 150 PSF
- Cradle and Base
  - Design Load Requirement – 628T
  - Detector Verti./Horiz. Alignment Requirements - ±0.020 in. Vert/Horiz. , ±0.050 in. longitudinal. (proposed)
  - Detector Travel Speed Requirement – 1’/min. (proposed)
- Vacuum Pipe
  - Reuse of 31.5 inch long beryllium section
- Conventional Systems
  - Cooling Water – provide 2 gpm @ 50F Supply - 2 KW/Rack
  - HVAC – 68F/50%RH
  - Existing 480V, 1200A Buss
  - TPC Gas System (if required)

*Requirements Established in sPHENIX PCDR

Infrastructure Description





Provide the detector Central Pedestal Support and Interconnecting hardware and support structures.

1. Support Pedestal, rollers, vertical and horizontal positioning assembly
2. End Ring for transitional support of the Inner Hcal Assembly to the Outer Hcal
3. Provide Electronics Bridge and Access Stairs
4. Magnet Pole Tips (Flux return endcaps)

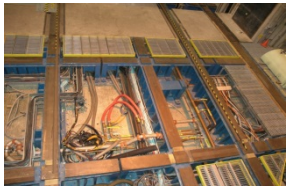
Existing Facility

Conventional Systems

- A/C Power
- Piping Supports (Cryo Pipe)
- Cable Tray
- Cooling Water
- Assembly Building/Control Room/Support Buildings
- HSSD, Leak Detection, Pass System, ODH
- Gas Distribution System (if required)

Existing Power

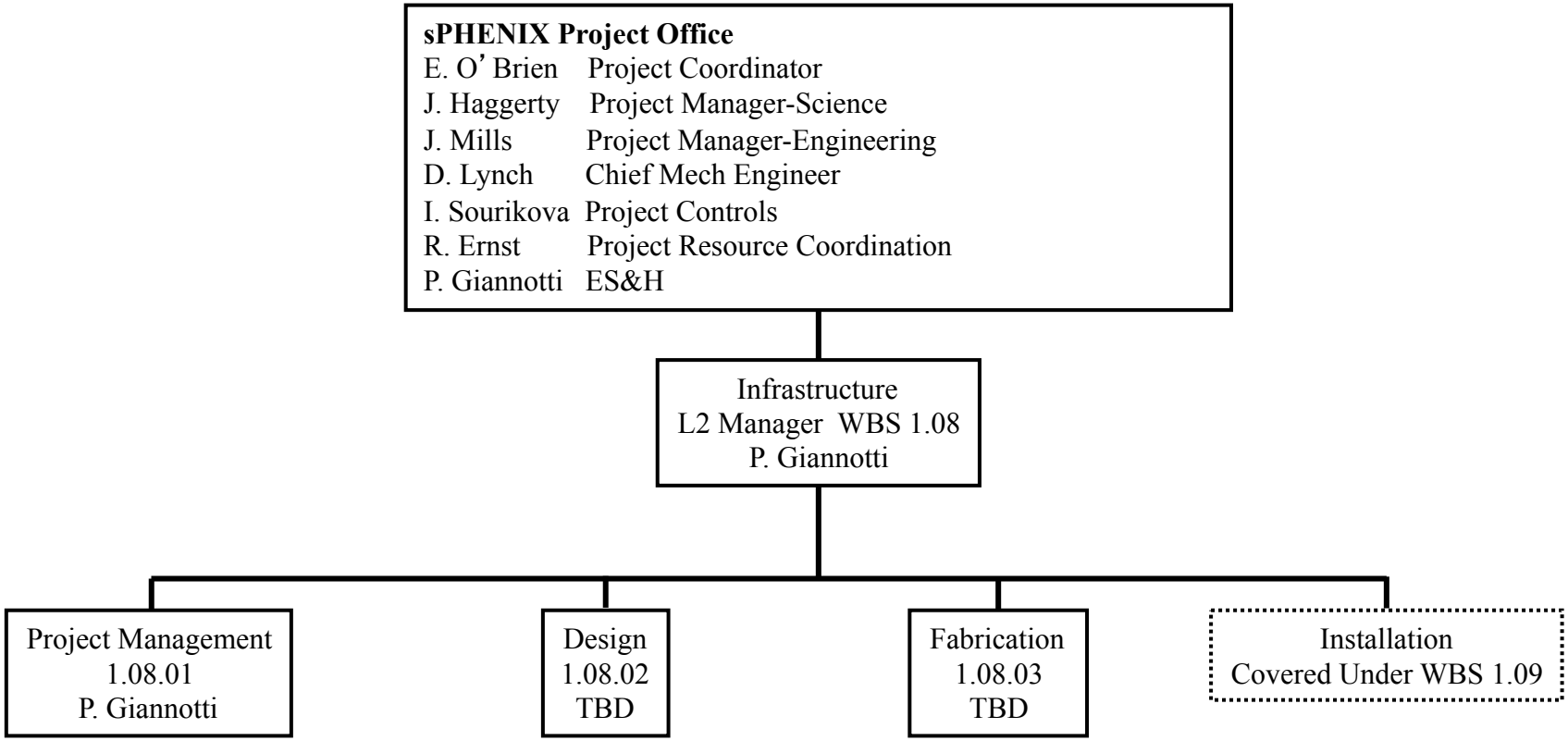
Existing Water System



Existing Distribution

Existing Power

Infrastructure Organization Chart



Infrastructure Schedule and Resource Requirements

Key Dates

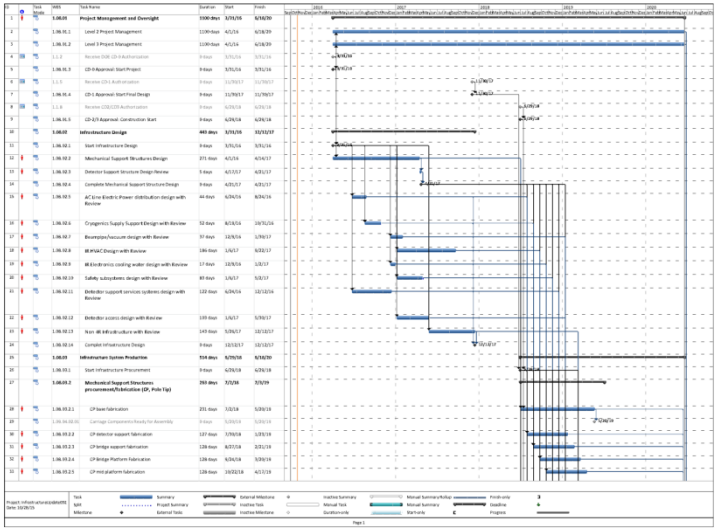
04/2016 Start Cradle and Baseplate Design

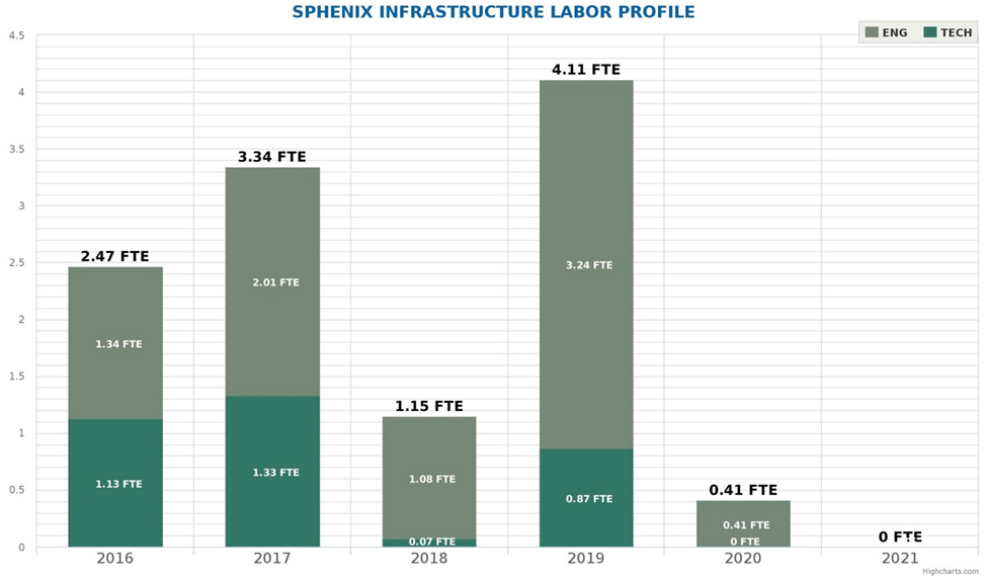
04/2017 Cradle and Baseplate Design Complete

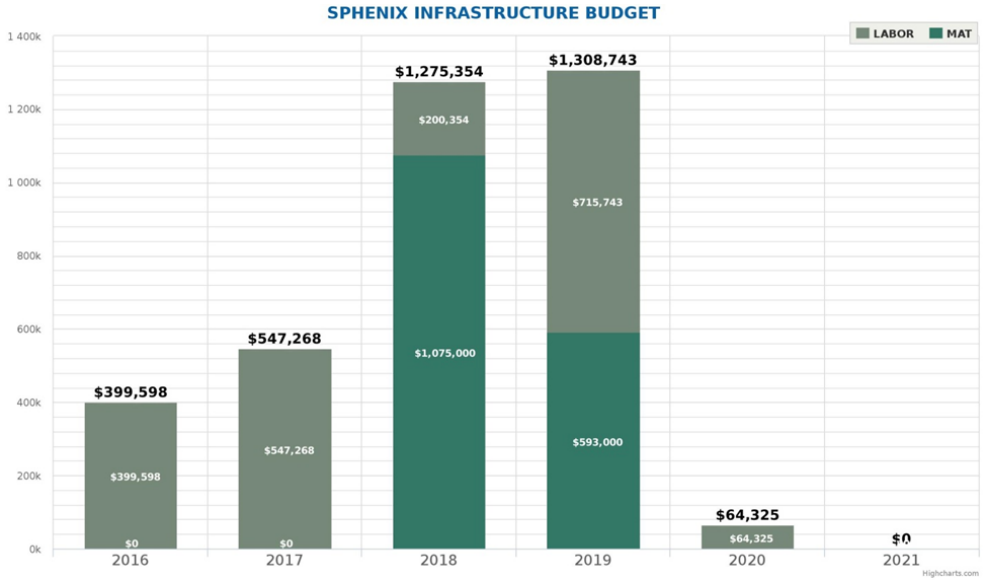
07/2018 Start Central Pedestal Fabrication

05/2019 Complete Central Pedestal Fabrication

Infrastructure Schedule







Infrastructure Cost and Schedule Drivers

Schedule Drivers

- Design of Detector Support Cradle, Base, and Bridge
- Fabrication time and availability for installation of Detector Cradle and Base (First article for detector construction)
- Cryo. Piping Supports and Building Modifications (elevated work)

Cost Drivers

- Fabrication of Detector Support Cradle and Base ($840K)
- Magnet Pole Tips ($240K)

Infrastructure Schedule and Technical Status

Technical

- Continuing to develop infrastructure requirements data for all detector subsystems.
- Start detailed study of detector support cradle and base.

Project

- Developing full Organization structure for subsystem.
- Preliminary Infrastructure schedule completed.
- Basis of Estimate document started.
- Preliminary Bottom's-Up Estimate complete on Infrastructure subsystem.

Infrastructure Issues and Concerns

Issue	Mitigation
Bring to maturity conceptual design of Cradle and base.	Perform engineering stress analysis and conceptual design work.
Bring to maturity conceptual design of pole tips in order to verify cost and optimize field uniformity.	Perform magnet field analysis, engineering stress analysis, and conceptual design work in spring of 2016.
Verify HVAC system is reusable with minimum maintenance/upgrade requirements	Work with Facility and Operations to perform condition assessment of HVAC system.
Bring to further maturity vacuum requirements and concept in IR	Work with Collider Accelerator department in performing preliminary engineering on the vacuum piping system in IR.
Solidify non-IR Infrastructure work.	Work with subsystem's managers on Infrastructure Requirements. If TPC system is chosen, will need to provide gas system (will repurpose existing gas distribution system for TPC).